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NATIONAL DAM SAFETY PROGRAM. LAKE HARMONY DAM (MO 30612), LOWER--ETC(U)
FEB 80 R J KIMBALL, J T HOCKENSMITH DACW43-79-C-0034

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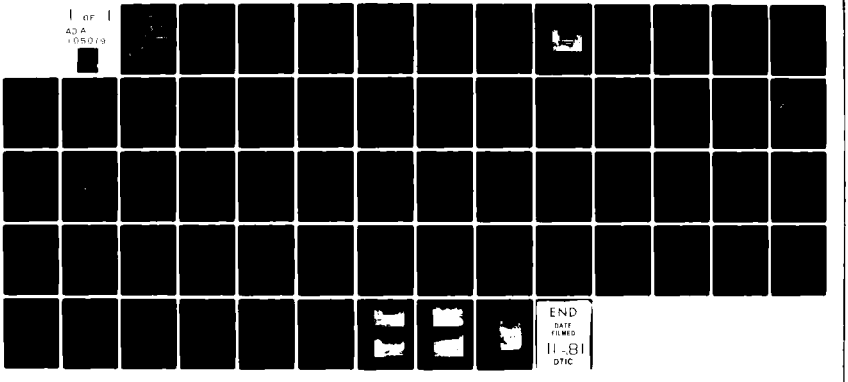

LOWER MISSISSIPPI - ST. FRANCIS BASIN

LEVEL II

LAKE HARMONY DAM

MADISON COUNTY, MISSOURI

MO 30612

(15) DACW43-79-C-0034

(9) Final rept., (11) Feb 80

(10) R. Jeffrey /Kimball James T./Hockensmith

(12) 62

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

(6) Lake Harmony Dam (MO 30612),
Lower Mississippi - St. Francis Basin,
Madison County, Missouri. Phase I Inspection
Report.

United States Army
Corps of Engineers
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PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

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FEBRUARY 1980

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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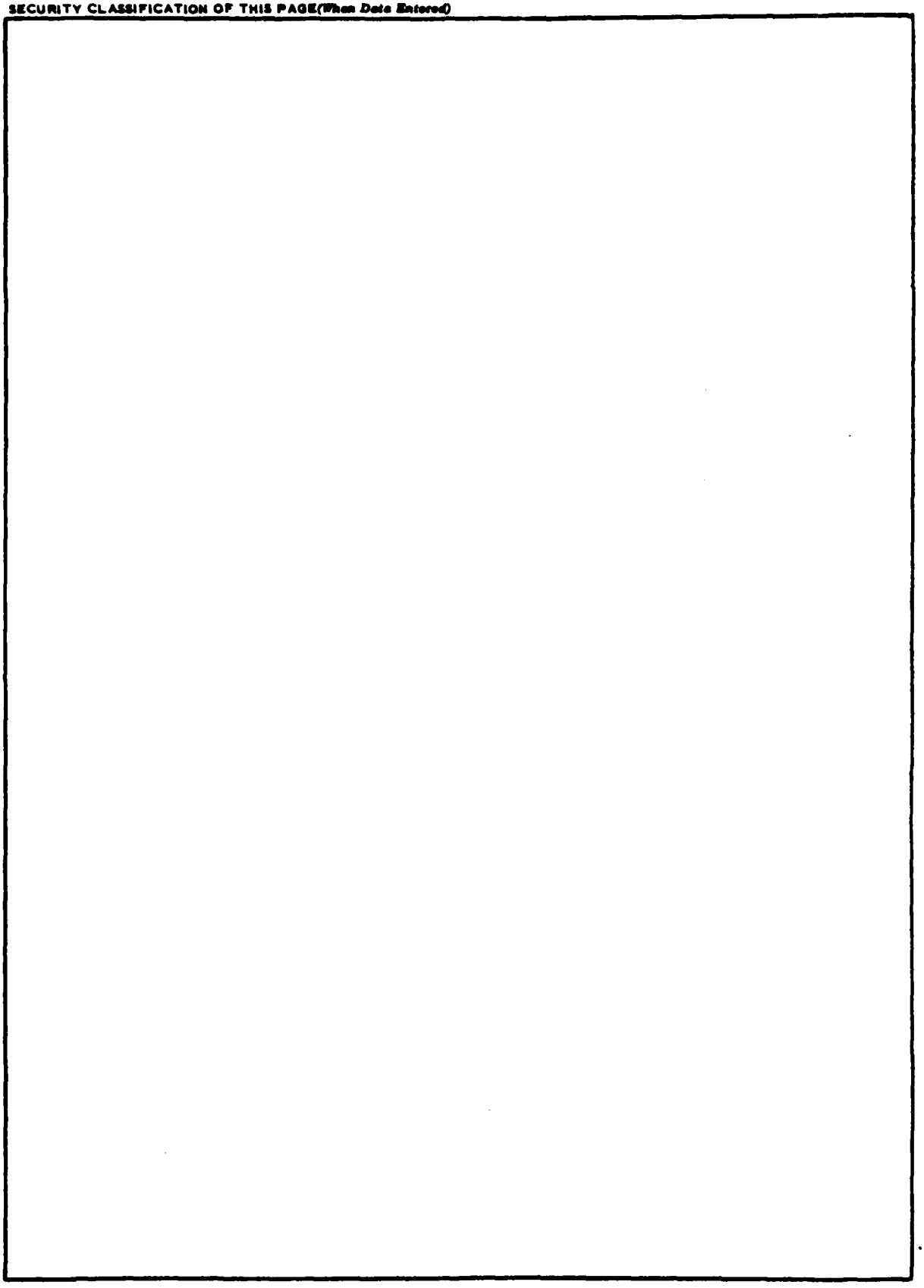

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

LMSED-FI

SUBJECT: Lake Harmony Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Harmony Dam (MO. 30612).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 10-year frequency flood without overtopping of the dam. The spillway is, therefore, considered to be unusually small and seriously inadequate.

b. Overtopping could result in dam failure.

c. Dam failure significantly increases the hazard to life and property downstream.

Submitted by: SIGNED — 14 APR 1980
Chief, Engineering Division — Date

Approved by: SIGNED — 14 APR 1980
Colonel, CE, District Engineer — Date

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in detemining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

NAME OF DAM	Lake Harmony Dam
STATE LOCATED	Missouri
COUNTY LOCATED	Madison
STREAM	Unnamed tributary to Little St. Francois River
DATE OF INSPECTION	September 5, 1979

Lake Harmony Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high-hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The dam is in the small size classification since it has a storage capacity greater than 50 acre-feet. The downstream damage zone extends for nine miles downstream of the dam. Within this estimated damage zone is two dwellings and several buildings, a railroad line, several highways and bridges and the Fredericktown City Water Dam.

Based on the downstream affected area the Spillway Design Flood for this dam is the PMF (Probable Maximum Flood). The spillway is capable of controlling approximately 6% of the PMF without overtopping the embankment. In addition, the spillway can not control the 10 year storm or the 100 year storm. The spillway is considered seriously inadequate.

Deficiencies visually observed for Lake Harmony Dam were no riprap on the upstream slope, seepage through the concrete portion of the dam and at the base of the concrete and vegetation (trees) growing on the upstream, downstream and crest of the dam. There is no warning system in effect or a safety inspection program. Stability and seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" are not available which is considered a deficiency. These deficiencies should be remedied at the direction of a professional engineer knowledgeable in the design and construction of concrete and earthfill dams.

R. JEFFREY KIMBALL, P.E.
L. Robert Kimball & Associates
Vice President, Earth Sciences

JAMES T. HOCKENSMITH
L. Robert Kimball & Associates
Geologist

Photograph No. 1

Overview of crest and upstream slope.

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NATIONAL DAM SAFETY PROGRAM
LAKE HARMONY DAM - I.D. NO. 30612

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Lake Harmony Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general conditon of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. Lake Harmony Dam is a combination concrete and earthfill dam. The concrete portion of the dam is approximately 16 feet high and is exposed on the downstream slope of the dam. The upper 5 feet of the dam is formed by an earth embankment, apparently due to raising the dam. The downstream portion of the slope varies from section to section but averages approximately 1H:1V. The upstream slope ranges from 1H:1V to 1.5H:1V. The crest width is approximately 6 feet. The dam is approximately 21 feet high and 524 feet long. The left abutment of the dam is formed by a roadway which is apparently on natural ground. Beyond the road (south) is an open strip mine or gravel pit.

The open cut spillway is located on the right abutment. The spillway exit channel flows along the downstream toe of the dam to the maximum section where it turns downstream (southwest).

A 6" and an 18" siphon are located on the embankment and downstream slope and is used to lower the reservoir.

b. Location. Lake Harmony Dam is located approximately 1 mile southwest of Mine LaMotte, Missouri, on an unnamed tributary to the Little St. Francois River. The dam can be located (Section 30, Township 34 North, Range 7 East) on the Fredericktown, Missouri 15 minute U.S.G.S. quadrangle.

c. Size Classification. Lake Harmony Dam is a small size structure (21 feet high, 343 acre-feet).

d. Hazard Classification. Lake Harmony Dam is a high hazard dam. Downstream conditions indicate that loss of life is probable should failure of the dam occur. The estimated damage zone downstream of the dam is approximately nine miles. Within this damage zone is two dwellings, several buildings, several highways and bridges and the Fredericktown City Water Dam.

e. Ownership. Lake Harmony Dam is owned by the Lake Harmony Property Owners Association, Inc.. Correspondence should be addressed to:

Mr. Darrell Mitchell
113 North Street
Farmington, Missouri 63640
314-756-5202

f. Purpose of Dam. Lake Harmony Dam is used for recreation.

g. Design and Construction History. Based on interviews with the owner Lake Harmony Dam, originally called Mine LaMotte Lake, was reportedly built 100 years ago. The present owner bought the dam in December, 1978. The dam was formerly owned by St. Joe Mineral Company. The present owner and St. Joe Mineral Company were contacted to obtain design information. No design drawings, reports or construction history was available and is assumed not to exist.

h. Normal Operating Procedures. No normal operations are conducted at the dam. However, periodically the siphons are used to lower the lake level. Excess inflow normally discharges over the spillway crest.

1.3 PERTINENT DATA

a. Drainage Area.

Lake Harmony (direct contributing)	3.4 square miles U.S.G.S. quadrangle
Lake LaMotte (upstream dam)	0.9 square miles U.S.G.S. quadrangle

b. Discharge at Damsite (cfs).

(1)	Maximum known flood at dam site	Unknown
(2)	Spillway capacity at top of dam	940
(3)	Drainlines	None

c. Elevation (feet) - Field survey based on spillway elevation 778 shown on U.S.G.S. quadrangle.

(1)	Top of dam	781
(2)	Spillway crest	778
(3)	Normal pool	778
(4)	Maximum pool (PMF)	786.9
(5)	Tailwater on day of inspection	None
(6)	Streambed at centerline of dam	760.0

d. Reservoir (feet).

(1)	Length of maximum pool	4000
(2)	Length of normal pool	3000

e. Storage (acre-feet).

(1)	Top of dam	343
(2)	Spillway crest	185
(3)	Normal pool	185
(4)	Maximum pool (PMF)	814

f. Reservoir Surface (acres).

(1)	Top of dam	65
(2)	Spillway crest	37
(3)	Normal pool	37
(4)	Maximum pool (PMF)	98

g. Dam.

(1)	Type	Concrete and earthfill
(2)	Length	524 feet
(3)	Height	21 feet
(4)	Top width	6 feet
(5)	Side slopes	Upstream - 1H:1V to 1.5H:1V Downstream - average 1H:1V
(6)	Zoning	Unknown
(7)	Grout curtain	Unknown
(8)	Cutoff	Unknown

h. Spillway.

(1)	Type	Earthen-trapezoidal
(2)	Length (bottom)	57 feet
(3)	Crest elevation	778 feet
(4)	Upstream channel	Lake
(5)	Downstream channel	narrow confined

i. Siphons.

(1)	Size	6" and 18"
(2)	Type	Have to be primed
(3)	Discharge	at toe of dam

SECTION 2 - ENGINEERING DATA

2.1 DESIGN. No design drawings, reports or data are known to exist.

2.2 CONSTRUCTION. Based on interviews with the owner and the former owner it is reported that the dam was constructed approximately 100 years ago. No information exists on the construction of the dam.

2.3 OPERATION. No operating records exist.

2.4 EVALUATION.

a. Availability. There are no engineering data available.

b. Adequacy. The field surveys and visual inspection presented herein are considered adequate to support the conclusion of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The onsite inspection of Lake Harmony Dam was conducted by personnel of L. Robert Kimball and Associates on September 5, 1979. The inspection team consisted of a hydrologist, structural/soils engineer and a geologist. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments, and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works, and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.

b. Project Geology. Lake Harmony and its dam are underlain by rocks of the Cambrian aged LaMotte formation. This formation is primarily a quartzose sandstone that may grade laterally into arkose or conglomerate. The sandstone, which may be yellow, gray, brown or red, often attains thicknesses of up to 500 feet and usually overlies the Precambrian basement rocks. The only exposure in the vicinity of the dam was in the spillway itself. This showed a buff colored sandstone with some jointing indicated. The beds were about one foot in thickness.

The area around Lake Harmony has experienced extensive faulting in the past. The Lake itself lies on an upthrown block on the west side of the Mine LaMotte faults. These northwest trending faults have a displacement of about 100 feet, causing the LaMotte sandstone to be brought against the Bonnetterre formation. These faults are believed to be part of the Doe Run - Higdon fault system which is, in turn, part of the Simms Mountain fault system.

c. Dam and Spillway. The visual inspection of the dam indicated that the structure was in fair condition. From a brief survey conducted during the inspection, it was determined that a low spot was present on the crest of the dam at the junction of the left abutment where the roadway comes in contact with the embankment. The downstream slope was measured to be approximately 1H:1V. The bottom portion of the downstream slope is formed by a concrete wall or concrete gravity section (extent and configuration unknown). This concrete section is approximately 16 feet high. It appears that the original dam was a concrete dam but has since has been raised 5 feet by placing an earth embankment over the concrete portion. This earth embank-

ment is approximately 5 feet high. The dimensions of the embankment are unknown since no drawings are available and the owner did not provide additional information. Seepage is exiting from the concrete wall and at the base of the wall. The seepage was estimated at approximately 5 gallons per minute. This seepage is exiting from a wide area. Because of the heavy vegetation in this area close examination was not possible. It appears that the seepage is exiting at the concrete/rock contact, through the rock and through the uncracked wall. The upstream slope of the embankment ranged from 1.5H:1V to 1H:1V. The crest width is narrow and averages 6 feet. The upstream slope, the downstream slope and the crest are covered with numerous small and large trees. Visible examination revealed that the embankment consists of a clayey sand with rock fragments.

The spillway is located on the right abutment and is formed by an open cut, trapezoidal shape. The bottom of the spillway is 57 feet long and cut in rock. The spillway exit channel bottom is formed by bedrock and extends along the toe of the dam to the maximum section of the dam where it turns to the southwest and flows into the unnamed tributary of the St. Francois River.

A 6" and an 18" steel siphon has been installed in the dam at the maximum section to lower the reservoir level. These siphons are not automatic and have to be primed.

Beyond the road which is located on the left abutment is a strip mine pit. The bottom of the strip mine pit (lead mine) is lower than the bottom of the reservoir. No seepage from the reservoir into the pit was observed.

d. Drainlines. The siphons are located at the maximum section of the dam. According to the owner the siphons can lower the water level approximately 6 feet.

e. Reservoir Area. No pertinent problems were noted in the reservoir area. The watershed is moderately flat. Approximately 2 miles upstream of Lake Harmony is Mine LaMotte Dam.

f. Downstream Channel. The unnamed tributary to the St. Francois River is narrow and confined.

3.2 EVALUATION. The visual inspection revealed that the dam appears to be in fair condition. The concrete portion appeared to be in fair condition with seepage exiting through portions of the concrete and at the base. No major cracks were noted in the concrete. The earth embankment portions of the dam also appear to be in fair condition.

Complete evaluation of the structure cannot be made without a detailed stability, stress or seepage analysis.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES. The reservoir is maintained at the spillway crest elevation. Excess inflow discharges over the spillway crest. Periodically (once each year) the owner operates the siphon to partially lower the reservoir.

4.2 MAINTENANCE OF DAM. No maintenance of the dam is conducted.

4.3 MAINTENANCE OF OPERATING FACILITIES. The operating facilities are not maintained.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT. Upon checking with the owner, the inspection team is unaware of any warning system in effect.

4.5 EVALUATION. Maintenance of the dam and operating facilities are considered poor. There is no warning system in effect to warn downstream residences of large spillway discharges or failure of the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There are no hydraulic or hydrological design data available as discussed in Section 2.

b. Experience Data. The drainage area was developed using the U.S.G.S. quadrangle sheet. The lake surface area was determined by planimetering the quadrangle sheet. Surface area -elevations were determined by planimetering various contour lines within the drainage area on the U.S.G.S. quadrangle sheets. The spillway and dam layout was made from surveys conducted from the inspection. Despite no record of reservoir water levels, there is no history of the dam being overtopped. However, it is unknown when the dam was raised the additional 5 feet and no information is available on the geometry and condition of the concrete portion of the dam. The dam may have been originally a concrete dam with a full overflow section.

c. Visual Observations. The low point on the dam located at the left abutment was used as the top of dam elevation. Upstream of Lake Harmony Dam is Mine LaMotte Dam which controls part of the contributing drainage area of Lake Harmony Dam.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, St. Louis District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydraulic Engineering Center (HEC) U.S. Army Corp of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed in Appendix B.

To enable us to complete the hydraulic and hyrologic analysis for this structure, it was necessary to make the following assumptions:

1. The top of dam was considered to be elevation 781.0.

2. No flow through the siphons was considered.

3. The flood was routed through Mine LaMotte Dam.

4. Failure of Mine LaMotte Dam was not considered.

Complete summary sheets for the computer output are presented in Appendix B. To facilitate review, the major results of the overtopping analysis are presented below:

Peak inflow	31,400 cfs
Spillway capacity	940 cfs

Ratio of PMF	Maximum Reservoir Water Surface	Maximum Depth over Dam (embankment)	Maximum Outflow, cfs	Duration of overtopping, hours
.10	781.91	.91	1557	3.00
.50	785.04	4.04	14466	9.33
1.00	786.91	5.91	30185	14.83

The Corps of Engineers Spillway Design Flood for a high hazard-small dam is 1/2 PMF to the PMF. Based on the downstream hazard exposure, the Spillway Design Flood for this dam has been selected to be the PMF. The spillway is capable of controlling approximately 6% of the PMF without overtopping the embankment. Overtopping of the embankment for an extended period of time will cause failure of the dam. Overtopping of the embankment for an extended period of time will cause failure of the dam.

Because of the low spillway capacity the 10 year storm was routed through the reservoir. The parameters for the 10 year storm were obtain from the St. Louis District Corps of Engineers. Based on parameters provided by the St. Louis District, Corps of Engineers, the spillway cannot control the 10 year storm. Past history may not be applicable since the dam was raised 5 feet and the spillway has been modified. The dam cannot control the 100 year storm.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations did not reveal any signs of immediate instability. The embankment portion of the dam appeared to be in fair condition. No slumps, major erosion areas or seepage was noted on the earth embankment portions of the dam. However, most of the earth embankment portion of the dam is above a normal water level. The concrete portion of the dam appeared to be in fair condition. No major cracks were noted. Seepage was found exiting through the concrete with most of the seepage exiting at the base of the concrete.

b. Design and Construction Data. No design or construction data is available on the dam. The dimensions of the dam cross section in particular the concrete portion of the dam are unknown. No testing of the concrete and earth embankment has been performed. Stability and seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspections of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operating records are kept on the structure.

d. Post Construction Changes. The post contruction changes for this structure have not been documented. The dam had been raised approximately 5 feet at an unknown date.

e. Seismic Stability. The dam is lcoated in seismic zone 2 to which the guidelines assign a "moderate" damage potential. No seismic stability analysis has been conducted.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. The visual observations, review of available data and hydrologic calculations indicate that Lake Harmony Dam's spillway is seriously inadequate. The spillway is capable of controlling approximately 6% of the PMF without overtopping the embankment. In addition, the spillway can not control the 10 year storm or the 100 year storm.

The earth embankment portion of the dam and the concrete portion of the dam both appeared to be in fair condition. Seepage was exiting through the concrete, through the rock and at the concrete/rock contact. The long term effect of the seepage and the extent of deterioration and weakening of the concrete is unknown. The concrete in the dam will deteriorate with age and should at analyzed in periodic intervals. Because of the lack of design and construction data the dimensions of the dam and concrete are unknown. Stability, stress and seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspections of Dams" were not available, which is considered a deficiency. Operation of the siphons was not conducted during the inspection. Removal of the trees on the slopes and the erosive nature of the clayey sand soils in the embankment requires that riprap should be provided on the upstream slope.

b. Adequacy of Information. Complete assessment of the structural stability of the structure cannot be made because of the limited design data and construction data. Stability and seepage analyses comparable to the requirement of the "Recommended Guidelines for Safety Inspections of Dams" were not available, which is considered a deficiency.

c. Urgency. The deficiencies described herein are serious and corrective actions listed in 7.2.b should be initiated on a high priority basis. Special note should be made of items in paragraph 7.2.a and these recommendations should be pursued immediately.

d. Need for Phase II. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required. However, a Phase II investigation is not required.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Alternatives. A detailed hydraulic and hydrology study should be conducted by a registered professional engineer knowledgeable in dam design to increase the spillway capacity. The study should begin immediately and remedial modifications begun immediately after the study is complete.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures and followup actions are recommended:

1. Stability, stress and seepage analyses should be conducted of the earth embankment portion of the dam and the concrete portion of the dam by a registered professional engineer knowledgeable in the design and construction of earth and concrete dams.

2. The extent and location, structural requirements and condition of the concrete should be determined.

3. The seepage through the concrete and at the base of the concrete should be monitored at periodic intervals.

4. Institute a formal inspection program to be conducted at regular intervals.

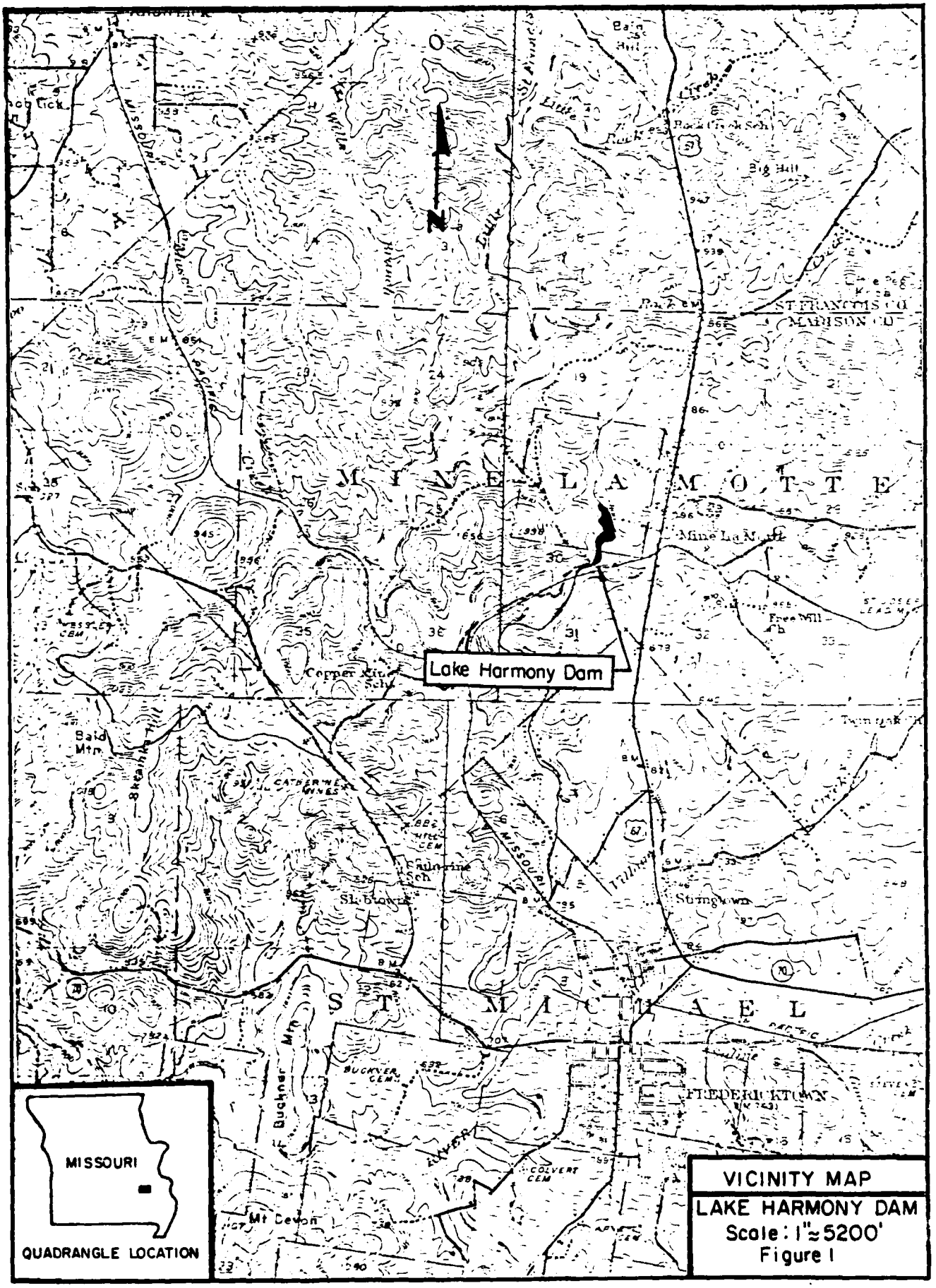
5. Institue a formal warning system to warn downstream residences of high spillway discharges or failure of the dam.

6. The siphon should be exercised at regular intervals.

7. Riprap should be provided on the upstream slope of the dam.

8. Trees growing on the dam should be removed under the direction of a professional engineer, experienced in the design of earth and concrete dams.

DRAWINGS


Lake Harmony Dam
MISSOURI
QUADRANGLE LOCATION
VICINITY MAP
LAKE HARMONY DAM
Scale: 1"≈5200'
Figure 1

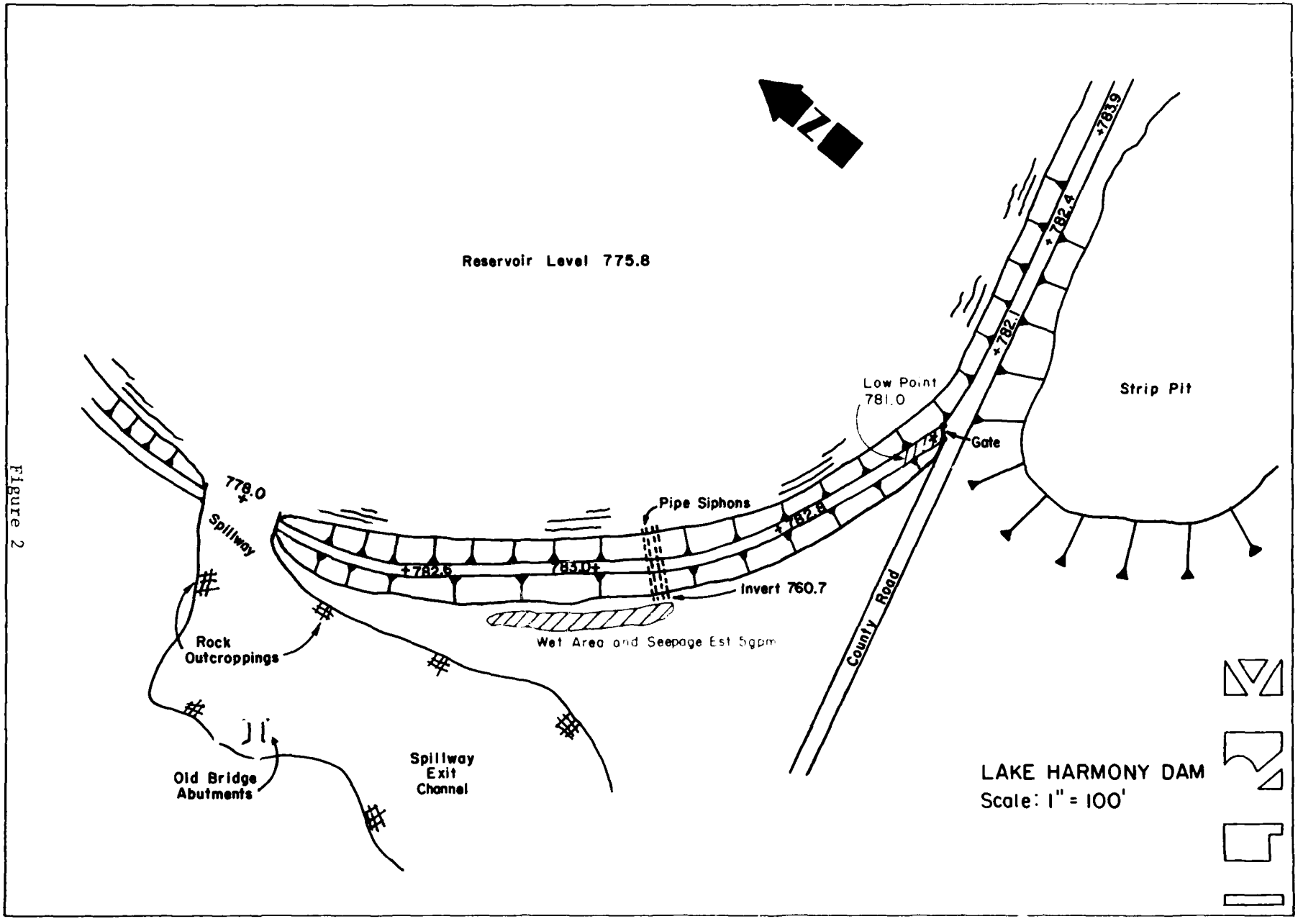

N
Reservoir Level 775.8
+783.9
+782.4
+782.1
Low Point
781.0
Strip Pit
Gate
778.0
Spillway
Pipe Siphons
+782.6
+782.5
783.0+
Invert 760.7
Wet Area and Seepage Est 5gpm
County Road
Rock
Outcroppings
Old Bridge
Abutments
Spillway
Exit
Channel
LAKE HARMONY DAM
Scale: 1" = 100'

Figure 2

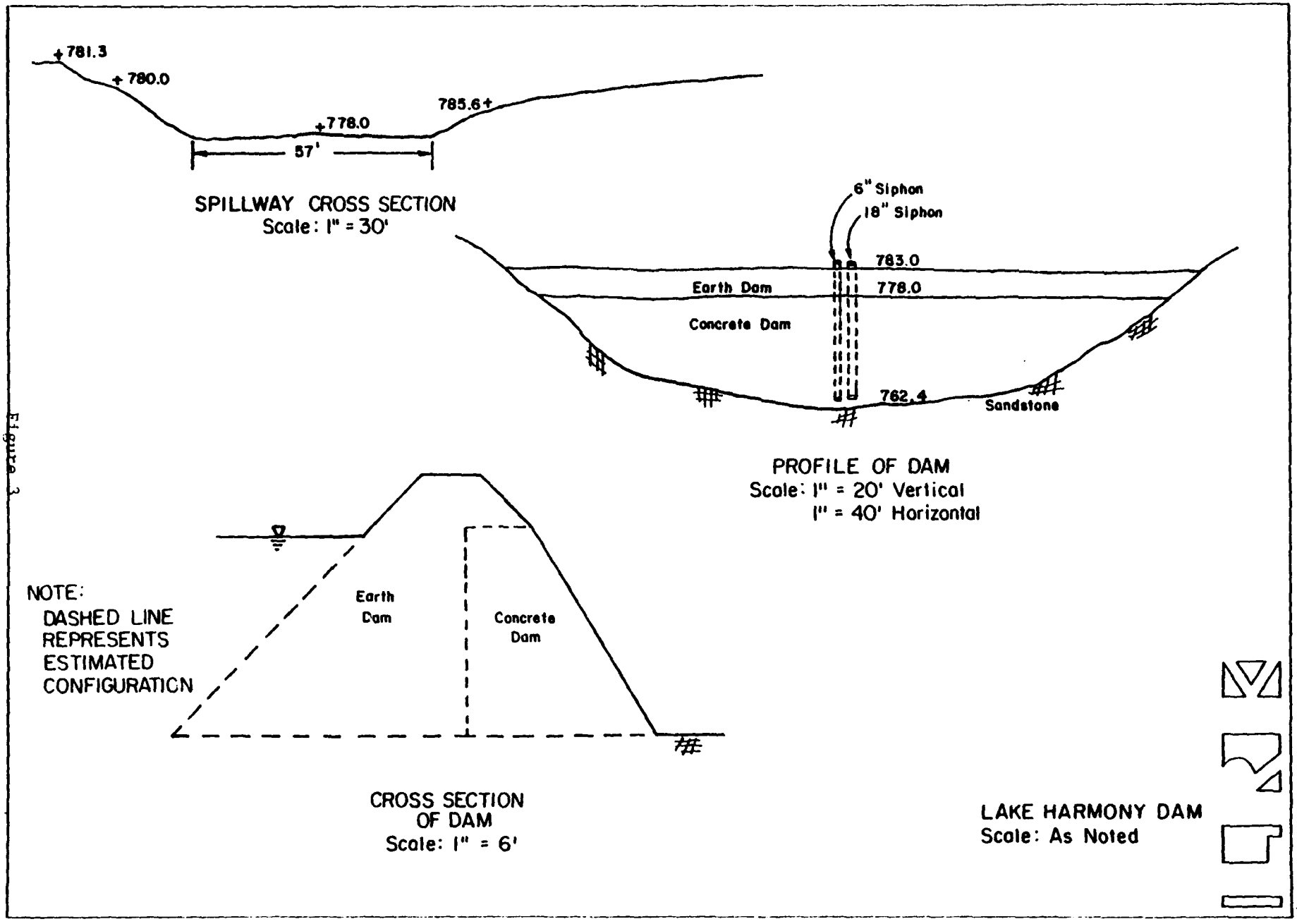
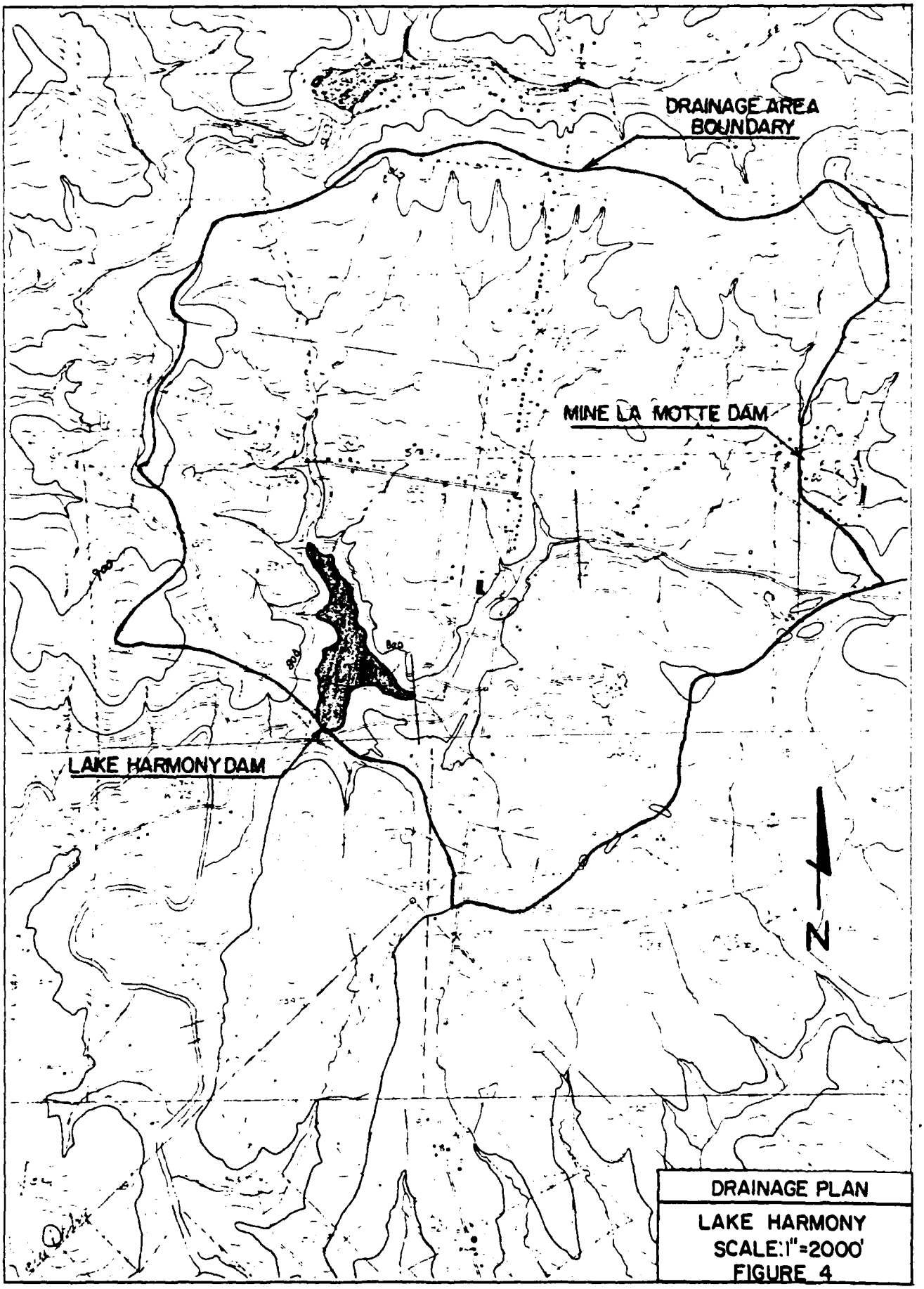

+781.3
+780.0
+778.0
785.6+
57'
SPILLWAY CROSS SECTION
Scale: 1" = 30'
6" Siphon
18" Siphon
783.0
Earth Dam
778.0
Concrete Dam
762.4
Sandstone
PROFILE OF DAM
Scale: 1" = 20' Vertical
1" = 40' Horizontal
NOTE:
DASHED LINE
REPRESENTS
ESTIMATED
CONFIGURATION
Earth
Dam
Concrete
Dam
CROSS SECTION
OF DAM
Scale: 1" = 6'
LAKE HARMONY DAM
Scale: As Noted

Figure 3



DRAINAGE PLAN

LAKE HARMONY
SCALE: 1"=2000'
FIGURE 4

HYDROLOGY AND HYDRAULICS

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 48 hour storm duration is assumed with total depth distributed over 6 hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6 hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The non-peak 6 hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by deduction of infiltration losses appropriate to the soil, land use, and antecedent moisture conditions.

The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillways, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillways, and top of dam are defined by elevation-discharge curves.

Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

The above analysis has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE HARMONY
I.D. NUMBER 30612
SHEET NO. 1 OF 4
BY OTM DATE 9-24-79

LAKE HARMONY

DRAINAGE AREA = 4.3 mi^2 (2755 ACRES)
3.4 mi^2 DIRECT CONTRIBUTING (2177 ACRES)
0.9 mi^2 MINE LA MOTTE DAM UPSTREAM (578 ACRES)

FROM U.S.G.S. 7.5-MIN. QUAD.

UNIT HYDROGRAPH PARAMETERS

KIRPICH:

t_c = 50 MIN OR 0.83 HRS. LAG = 0.6 t_c = 0.50 HRS.
WHERE LENGTH (L) = 10,000 FT.
HEIGTH (H) = 122 FT.

FROM TIME OF CONCENTRATION NOMOGRAPH, KENTUCKY BUREAU OF HIGHWAYS.

CURVE NUMBER METHOD:

$$LAG = \frac{l^{0.8}(S+1)^{0.7}}{1900\ Y^{0.5}} = \frac{(10,000)^{0.8}(2.49)^{0.7}}{1900\ (3.0)^{0.5}}$$

$$= \frac{(1585)(1.89)}{3291} = 0.91 \text{ HRS.}$$

WHERE l = GREATEST FLOW LENGTH IN FEET.
$S = \frac{1000}{CN} - 10$ AND CN = S.C.S. CURVE NUMBER
Y = AVERAGE SLOPE

CN = 87, ANTECEDENT MOISTURE CONDITION III
SOIL GROUP "C".

FROM S.C.S.

USED TIME OF CONCENTRATION IN THIS ANALYSIS = 0.83 HRS, LAG = 0.5 HRS

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EBENSBURG PENNSYLVANIA

DAM NAME LAKE HARMONY
I.D. NUMBER 30612
SHEET NO. 2 OF 4
BY OTM DATE 9-24-79

LOSS RATE AND BASE FLOW

STRTL = 1 INCH
CNSTL = 87 SCS CURVE NO. (AMC III)
STRTQ = 1.5 cfs/mi²
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.5

PROBABLE MAXIMUM STORM

FROM H.R. No. 33

P.M.P. INDEX RAINFALL (ZONE 7) = 26.5 INCHES
R_6 = 102%, R_{12} = 120%, R_{24} = 130%, R_{48} = 140%

ELEVATION - AREA - CAPACITY RELATIONSHIP

SPILLWAY CREST ELEV. = 778.0'
INITIAL STORAGE = 184 AC.FT (ST. LOUIS DIST. C.O.E.)

FROM U.S.G.S. 7.5-MIN. QUAD.

AT ELEV. 778, AREA = 37 AC.
" " 780, " = 60 AC.
" " 800, " = 135 AC.

FROM THE CONIC METHOD FOR RESERVOIR VOLUME. FLOOD HYDROGRAPH PACKAGE (HEC-1). DAM SAFETY VERSION USERS MANUAL.

$H = 3V/A = 3(184)/37 \simeq 15'$
ELEV. WHERE AREA EQUALS ZERO:
778' - 15' = 763'

$A	0	37	60	80	90	100	120	135
$E	763	778	780	784	786	789	795	800

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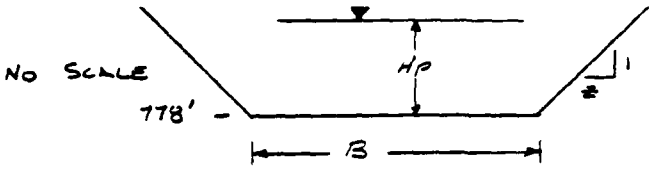
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE HARMONY
I.D. NUMBER 30612
SHEET NO. 3 OF 4
BY OTM DATE 9-24-79

SPILLWAY DISCHARGE

SPILLWAY CREST = 778'



Hp = VARIABLE
Z = 2.25
B = 57'
USE C' = 0.95

FROM EQ. FOR TRAPEZOIDAL SPILLWAY FLOW.

$$Q = 8.03\, C'\, hv^{1/2}(hp-hv)\,[B+Z(hp-hv)]$$

WHERE $$hv = \frac{3(2Z\,hp+B)-(16Z^2hp^2+16ZBhp+9B^2)^{1/2}}{10Z}$$

LOW DAMS p. 79, NATIONAL RESOURCE COMM.

WATER AND WASTEWATER ENGINEERING p. 11-34, FAIR, GEYER, AND OKUN

ELEVATION (FT.)	TRAPEZOIDAL FLOW	
	HEIGHT (FT.)	*DISCHARGE (c.f.s.)
778	0	—
779	1	170
780	2	500
781	3	940 (TOP OF DAM)
782	4	1,480
783	5	2,120
784	6	2,860
785	7	3,680
790	12	9,240
800	22	27,810

* DISCHARGE ROUNDED TO NEAREST 10 c.f.s.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

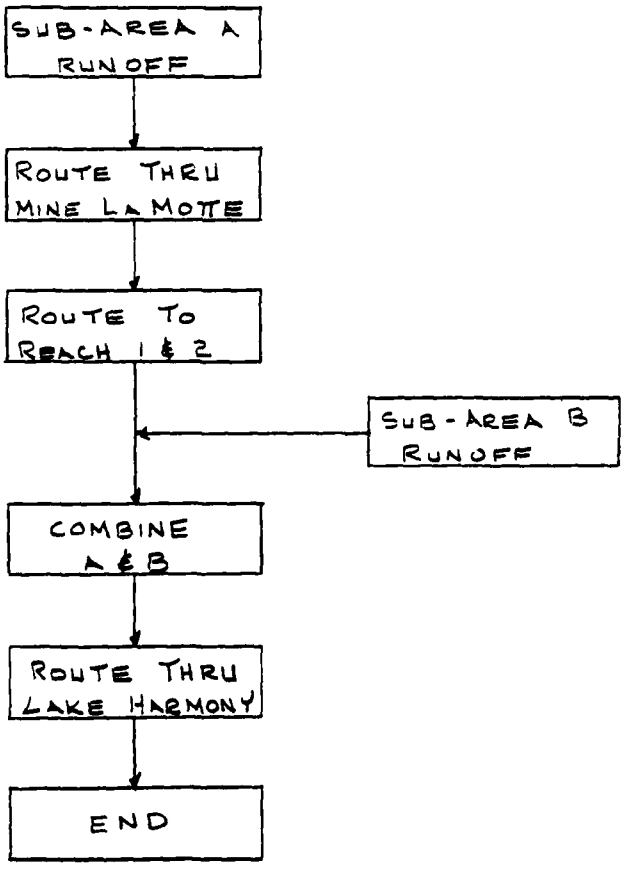
DAM NAME LAKE HARMONY
I.D. NUMBER 30612
SHEET NO. 4 OF 4
BY OTM DATE 9-25-79

OVERTOP PARAMETERS

DISCHARGE DETERMINED BY (HEC-1)

TOP OF DAM ELEV. (LOW SPOT) = 781'
LENGTH OF DAM (EXCLUDING S.W.) = 524'
COEFFICIENT OF DISCHARGE = 2.9 (BROAD CREST)
$L_{MAX.}$ = 923' $Y_{MAX.}$ = 787'

UPSTREAM CONDITIONS (SCHEMATIC NETWORK)



```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1        A1    ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2        A2    HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE HARMONY DAM
    3        A3    RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (MISSOURI - 306121
    4        B   288       0      10       0       0       0       0       0       0       0
    5        B1  5
    6        J   1       3       1
    7        J1  .1      .5      1
    8        K   0       1                                               1
    9        K1    INFLOW SUB-AREA(A)
   10        M   1       2      0.9                      4.3     1                       1
   11        P           26.5    102     120     130     140
   12        T                                                   -1      -87
   13        W2          0.3
   14        X   -1.5    -.05    2.5
   15        K   1       2                                               1
   16        K1    ROUTE THRU LAMOTTE
   17        Y                                   1       1
   18        Y1  1                                                   -881    -1
   19        Y4  881     882     883     884     885     886     888     890     895     900
   20        Y5  0       40      140     300     510     800     1610    2760    7340    14760
   21        SA  0       18      30      41      50      60      73
   22        SE  869     881     886     890     893     896     900
   23        SS  881
   24        SD  883.9   2.9     1.5     750
   25        SL  70      300     635     790     890     995     1100
   26        SV  883.9   884     884.4   885     890     895     900
   27        K   1       3                                               1
   28        K1    REACH 2-3
   29        Y                                   1       1
   30        Y1  1
   31        Y6  .06     .05     .06     798     840     4000    .0200
   32        Y7  0       840     200     820     550     800     570     798     580     798
   33        Y7  600     800     700     820     1200
   34        K   1       4                                               1
   35        K1    REACH 3-4
   36        Y                                   1       1
   37        Y1  1
   38        Y6  .06     .05     .06     776     800     4000    0.0055
   39        Y7  0       800     375     780     600     778     658     776     668     776
   40        Y7  725     778     800     780     900     800
   41        K   0       5                                               1
   42        K1    INFLOW SUB-AREA(B)
   43        M   1       2      3.4                      4.3     1                       1
   44        P           26.5    102     120     130     140
   45        T                                                   -1      -87
   46        W2          0.2
   47        X   -1.5    -.05    2.5
   48        K   2       6                                               1
   49        K1    COMBINE
   50        K   1       6                                               1
```

```
51          K1      ROUTE THRU LAKE HARMONY
52          Y                                       1       1
53          Y1      1                                                   -778    -1
54          Y4      778     779     780     781     782     783     784     785     790     800
55          Y5      0       170     500     940     1480    2120    2860    3680    9240    27810
56          SA      0       37      60      80      90      100     120     135
57          SE      763     778     780     784     786     789     795     800
58          SS      778
59          SD      781     2.9     1.5     524
60          SL      5       127     750     835     920     1015    1100    1200    1290    1500
61          SV      781     787     783     785     787     789     791     793     795     800
62          K       99
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 79/09/28.
     TIME= 07.52.29.
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE HARMONY DAM
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (MISSOURI - 306121

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 3 LRTIO= 1

RTIOS= .10 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW SUB-AREA(A)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.90	0.00	4.30	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.50	102.00	120.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-87.00	0.00	0.00

CURVE NO = -87.00 WETNESS = -1.00 EFFECT CN = 87.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .30

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.50

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 11 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .30 VOL= 1.00

	418.	1110.	979.	494.	247.	121.	59.	30.	15.	8.
	2.									

0						END-OF-PERIOD FLOW							
MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.00	0.00	.00	1.	1.02	.10	145	.03	.03	.00	19.
1.01	.20	2	.00	0.00	.00	1.	1.02	.20	146	.03	.03	.00	44.
1.01	.30	3	.00	0.00	.00	1.	1.02	.30	147	.03	.03	.00	66.
1.01	.40	4	.00	0.00	.00	1.	1.02	.40	148	.03	.03	.00	77.
1.01	.50	5	.00	0.00	.00	1.	1.02	.50	149	.03	.03	.00	82.
1.01	1.00	6	.00	0.00	.00	1.	1.02	1.00	150	.03	.03	.00	85.
1.01	1.10	7	.00	0.00	.00	1.	1.02	1.10	151	.03	.03	.00	87.
1.01	1.20	8	.00	0.00	.00	1.	1.02	1.20	152	.03	.03	.00	88.
1.01	1.30	9	.00	0.00	.00	1.	1.02	1.30	153	.03	.03	.00	88.
1.01	1.40	10	.00	0.00	.00	1.	1.02	1.40	154	.03	.03	.00	89.
1.01	1.50	11	.00	0.00	.00	0.	1.02	1.50	155	.03	.03	.00	89.
1.01	2.00	12	.00	0.00	.00	0.	1.02	2.00	156	.03	.03	.00	89.
1.01	2.10	13	.00	0.00	.00	0.	1.02	2.10	157	.03	.03	.00	89.
1.01	2.20	14	.00	0.00	.00	0.	1.02	2.20	158	.03	.03	.00	89.
1.01	2.30	15	.00	0.00	.00	0.	1.02	2.30	159	.03	.03	.00	90.
1.01	2.40	16	.00	0.00	.00	0.	1.02	2.40	160	.03	.03	.00	90.
1.01	2.50	17	.00	0.00	.00	0.	1.02	2.50	161	.03	.03	.00	90.
1.01	3.00	18	.00	0.00	.00	0.	1.02	3.00	162	.03	.03	.00	90.
1.01	3.10	19	.00	0.00	.00	0.	1.02	3.10	163	.03	.03	.00	90.
1.01	3.20	20	.00	0.00	.00	0.	1.02	3.20	164	.03	.03	.00	91.
1.01	3.30	21	.00	0.00	.00	0.	1.02	3.30	165	.03	.03	.00	91.
1.01	3.40	22	.00	0.00	.00	0.	1.02	3.40	166	.03	.03	.00	91.
1.01	3.50	23	.00	0.00	.00	0.	1.02	3.50	167	.03	.03	.00	91.
1.01	4.00	24	.00	0.00	.00	0.	1.02	4.00	168	.03	.03	.00	91.
1.01	4.10	25	.00	0.00	.00	0.	1.02	4.10	169	.03	.03	.00	91.
1.01	4.20	26	.00	0.00	.00	0.	1.02	4.20	170	.03	.03	.00	91.
1.01	4.30	27	.00	0.00	.00	0.	1.02	4.30	171	.03	.03	.00	92.
1.01	4.40	28	.00	0.00	.00	0.	1.02	4.40	172	.03	.03	.00	92.
1.01	4.50	29	.00	0.00	.00	0.	1.02	4.50	173	.03	.03	.00	92.
1.01	5.00	30	.00	0.00	.00	0.	1.02	5.00	174	.03	.03	.00	92.
1.01	5.10	31	.00	0.00	.00	0.	1.02	5.10	175	.03	.03	.00	92.
1.01	5.20	32	.00	0.00	.00	0.	1.02	5.20	176	.03	.03	.00	92.
1.01	5.30	33	.00	0.00	.00	0.	1.02	5.30	177	.03	.03	.00	92.
1.01	5.40	34	.00	0.00	.00	0.	1.02	5.40	178	.03	.03	.00	93.
1.01	5.50	35	.00	0.00	.00	0.	1.02	5.50	179	.03	.03	.00	93.
1.01	6.00	36	.00	0.00	.00	0.	1.02	6.00	180	.03	.03	.00	93.
1.01	6.10	37	.01	0.00	.01	0.	1.02	6.10	181	.13	.12	.01	132.
1.01	6.20	38	.01	0.00	.01	0.	1.02	6.20	182	.13	.12	.01	237.
1.01	6.30	39	.01	0.00	.01	0.	1.02	6.30	183	.13	.12	.01	329.
1.01	6.40	40	.01	0.00	.01	0.	1.02	6.40	184	.13	.12	.01	377.
1.01	6.50	41	.01	0.00	.01	0.	1.02	6.50	185	.13	.12	.01	402.
1.01	7.00	42	.01	0.00	.01	0.	1.02	7.00	186	.13	.12	.01	415.
1.01	7.10	43	.01	0.00	.01	0.	1.02	7.10	187	.13	.12	.01	422.
1.01	7.20	44	.01	0.00	.01	0.	1.02	7.20	188	.13	.12	.01	427.
1.01	7.30	45	.01	0.00	.01	0.	1.02	7.30	189	.13	.12	.01	429.
1.01	7.40	46	.01	0.00	.01	0.	1.02	7.40	190	.13	.12	.01	432.
1.01	7.50	47	.01	0.00	.01	0.	1.02	7.50	191	.13	.13	.01	433.
1.01	8.00	48	.01	0.00	.01	0.	1.02	8.00	192	.13	.13	.01	434.
1.01	8.10	49	.01	0.00	.01	0.	1.02	8.10	193	.13	.13	.01	435.
1.01	8.20	50	.01	0.00	.01	0.	1.02	8.20	194	.13	.13	.01	437.
1.01	8.30	51	.01	0.00	.01	0.	1.02	8.30	195	.13	.13	.01	438.
1.01	8.40	52	.01	0.00	.01	0.	1.02	8.40	196	.13	.13	.01	438.
1.01	8.50	53	.01	0.00	.01	0.	1.02	8.50	197	.13	.13	.01	439.
1.01	9.00	54	.01	0.00	.01	0.	1.02	9.00	198	.13	.13	.01	440.

1.01	9.10	55	.01	0.00	.01	0.	1.02	9.10	199	.13	.13	.01	441.
1.01	9.20	56	.01	0.00	.01	0.	1.02	9.20	200	.13	.13	.01	442.
1.01	9.30	57	.01	0.00	.01	0.	1.02	9.30	201	.13	.13	.01	442.
1.01	9.40	58	.01	.00	.01	0.	1.02	9.40	202	.13	.13	.00	443.
1.01	9.50	59	.01	.00	.01	0.	1.02	9.50	203	.13	.13	.00	444.
1.01	10.00	60	.01	.00	.01	0.	1.02	10.00	204	.13	.13	.00	444.
1.01	10.10	61	.01	.00	.01	1.	1.02	10.10	205	.13	.13	.00	445.
1.01	10.20	62	.01	.00	.01	1.	1.02	10.20	206	.13	.13	.00	445.
1.01	10.30	63	.01	.00	.01	2.	1.02	10.30	207	.13	.13	.00	446.
1.01	10.40	64	.01	.00	.01	2.	1.02	10.40	208	.13	.13	.00	446.
1.01	10.50	65	.01	.00	.01	2.	1.02	10.50	209	.13	.13	.00	447.
1.01	11.00	66	.01	.00	.01	3.	1.02	11.00	210	.13	.13	.00	447.
1.01	11.10	67	.01	.00	.01	3.	1.02	11.10	211	.13	.13	.00	448.
1.01	11.20	68	.01	.00	.01	4.	1.02	11.20	212	.13	.13	.00	448.
1.01	11.30	69	.01	.00	.01	4.	1.02	11.30	213	.13	.13	.00	449.
1.01	11.40	70	.01	.00	.01	4.	1.02	11.40	214	.13	.13	.00	449.
1.01	11.50	71	.01	.00	.01	5.	1.02	11.50	215	.13	.13	.00	449.
1.01	12.00	72	.01	.00	.01	5.	1.02	12.00	216	.13	.13	.00	450.
1.01	12.10	73	.03	.01	.03	8.	1.02	12.10	217	.45	.44	.01	580.
1.01	12.20	74	.03	.01	.03	14.	1.02	12.20	218	.45	.44	.01	926.
1.01	12.30	75	.03	.01	.03	20.	1.02	12.30	219	.45	.44	.01	1231.
1.01	12.40	76	.03	.01	.02	26.	1.02	12.40	220	.45	.44	.01	1387.
1.01	12.50	77	.03	.01	.02	30.	1.02	12.50	221	.45	.44	.01	1466.
1.01	13.00	78	.03	.01	.02	34.	1.02	13.00	222	.45	.44	.01	1506.
1.01	13.10	79	.04	.02	.03	38.	1.02	13.10	223	.54	.53	.01	1564.
1.01	13.20	80	.04	.02	.03	44.	1.02	13.20	224	.54	.53	.01	1673.
1.01	13.30	81	.04	.02	.02	51.	1.02	13.30	225	.54	.53	.01	1767.
1.01	13.40	82	.04	.02	.02	55.	1.02	13.40	226	.54	.53	.01	1815.
1.01	13.50	83	.04	.02	.02	60.	1.02	13.50	227	.54	.54	.01	1840.
1.01	14.00	84	.04	.02	.02	63.	1.02	14.00	228	.54	.54	.01	1852.
1.01	14.10	85	.05	.03	.03	69.	1.02	14.10	229	.68	.67	.01	1915.
1.01	14.20	86	.05	.03	.02	78.	1.02	14.20	230	.68	.67	.01	2068.
1.01	14.30	87	.05	.03	.02	87.	1.02	14.30	231	.68	.67	.01	2201.
1.01	14.40	88	.05	.03	.02	91.	1.02	14.40	232	.68	.67	.00	2270.
1.01	14.50	89	.05	.03	.02	99.	1.02	14.50	233	.68	.67	.00	2305.
1.01	15.00	90	.05	.03	.02	103.	1.02	15.00	234	.68	.67	.00	2322.
1.01	15.10	91	.05	.03	.02	105.	1.02	15.10	235	.62	.61	.00	2306.
1.01	15.20	92	.08	.05	.03	114.	1.02	15.20	236	1.03	1.02	.01	2417.
1.01	15.30	93	.14	.10	.05	155.	1.02	15.30	237	1.85	1.84	.01	3157.
1.01	15.40	94	.36	.26	.10	293.	1.02	15.40	238	4.62	4.61	.02	5594.
1.01	15.50	95	.10	.08	.02	453.	1.02	15.50	239	1.34	1.33	.00	8286.
1.01	16.00	96	.06	.05	.01	427.	1.02	16.00	240	.82	.82	.00	7642.
1.01	16.10	97	.05	.04	.01	308.	1.02	16.10	241	.63	.63	.00	5405.
1.01	16.20	98	.05	.04	.01	225.	1.02	16.20	242	.63	.63	.00	3879.
1.01	16.30	99	.05	.04	.01	179.	1.02	16.30	243	.63	.63	.00	3023.
1.01	16.40	100	.05	.04	.01	157.	1.02	16.40	244	.63	.63	.00	2600.
1.01	16.50	101	.05	.04	.01	146.	1.02	16.50	245	.63	.63	.00	2395.
1.01	17.00	102	.05	.04	.01	141.	1.02	17.00	246	.63	.63	.00	2292.
1.01	17.10	103	.04	.03	.01	136.	1.02	17.10	247	.50	.49	.00	2186.
1.01	17.20	104	.04	.03	.01	126.	1.02	17.20	248	.50	.49	.00	2004.
1.01	17.30	105	.04	.03	.01	117.	1.02	17.30	249	.50	.49	.00	1858.
1.01	17.40	106	.04	.03	.01	113.	1.02	17.40	250	.50	.49	.00	1788.
1.01	17.50	107	.04	.03	.01	112.	1.02	17.50	251	.50	.49	.00	1754.
1.01	18.00	108	.04	.03	.01	111.	1.02	18.00	252	.50	.49	.00	1738.
1.01	18.10	109	.00	.00	.00	99.	1.02	18.10	253	.04	.04	.00	1542.
1.01	18.20	110	.00	.00	.00	67.	1.02	18.20	254	.04	.04	.00	1038.
1.01	18.30	111	.00	.00	.00	38.	1.02	18.30	255	.04	.04	.00	595.
1.01	18.40	112	.00	.00	.00	24.	1.02	18.40	256	.04	.04	.00	407.
1.01	18.50	113	.00	.00	.00	21.	1.02	18.50	257	.04	.04	.00	372.
1.01	19.00	114	.00	.00	.00	19.	1.02	19.00	258	.04	.04	.00	339.

1.01	19.10	115	.00	.00	.00	17.	1.02	19.10	259	.04	.04	.00	309.
1.01	19.20	116	.00	.00	.00	16.	1.02	19.20	260	.04	.04	.00	282.
1.01	19.30	117	.00	.00	.00	15.	1.02	19.30	261	.04	.04	.00	258.
1.01	19.40	118	.00	.00	.00	13.	1.02	19.40	262	.04	.04	.00	235.
1.01	19.50	119	.00	.00	.00	12.	1.02	19.50	263	.04	.04	.00	214.
1.01	20.00	120	.00	.00	.00	11.	1.02	20.00	264	.04	.04	.00	196.
1.01	20.10	121	.00	.00	.00	10.	1.02	20.10	265	.04	.04	.00	179.
1.01	20.20	122	.00	.00	.00	10.	1.02	20.20	266	.04	.04	.00	163.
1.01	20.30	123	.00	.00	.00	10.	1.02	20.30	267	.04	.04	.00	154.
1.01	20.40	124	.00	.00	.00	10.	1.02	20.40	268	.04	.04	.00	154.
1.01	20.50	125	.00	.00	.00	10.	1.02	20.50	269	.04	.04	.00	154.
1.01	21.00	126	.00	.00	.00	10.	1.02	21.00	270	.04	.04	.00	154.
1.01	21.10	127	.00	.00	.00	10.	1.02	21.10	271	.04	.04	.00	154.
1.01	21.20	128	.00	.00	.00	10.	1.02	21.20	272	.04	.04	.00	154.
1.01	21.30	129	.00	.00	.00	10.	1.02	21.30	273	.04	.04	.00	154.
1.01	21.40	130	.00	.00	.00	10.	1.02	21.40	274	.04	.04	.00	154.
1.01	21.50	131	.00	.00	.00	10.	1.02	21.50	275	.04	.04	.00	154.
1.01	22.00	132	.00	.00	.00	10.	1.02	22.00	276	.04	.04	.00	154.
1.01	22.10	133	.00	.00	.00	10.	1.02	22.10	277	.04	.04	.00	154.
1.01	22.20	134	.00	.00	.00	10.	1.02	22.20	278	.04	.04	.00	154.
1.01	22.30	135	.00	.00	.00	10.	1.02	22.30	279	.04	.04	.00	154.
1.01	22.40	136	.00	.00	.00	10.	1.02	22.40	280	.04	.04	.00	154.
1.01	22.50	137	.00	.00	.00	10.	1.02	22.50	281	.04	.04	.00	154.
1.01	23.00	138	.00	.00	.00	10.	1.02	23.00	282	.04	.04	.00	154.
1.01	23.10	139	.00	.00	.00	10.	1.02	23.10	283	.04	.04	.00	154.
1.01	23.20	140	.00	.00	.00	10.	1.02	23.20	284	.04	.04	.00	154.
1.01	23.30	141	.00	.00	.00	10.	1.02	23.30	285	.04	.04	.00	154.
1.01	23.40	142	.00	.00	.00	10.	1.02	23.40	286	.04	.04	.00	154.
1.01	23.50	143	.00	.00	.00	10.	1.02	23.50	287	.04	.04	.00	154.
1.02	0.00	144	.00	.00	.00	10.	1.03	0.00	288	.04	.04	.00	154.
									SUM	37.10	35.37	1.73	123769.
										(942.1(	898.1(	44.1(| 3504.7)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8286.	2556.	824.	429.	123690.
CMS	235.	72.	23.	12.	3503.
INCHES		.26.42	34.07	35.51	35.51
MM		671.14	865.35	902.02	902.02
AC-FT		1268.	1634.	1704.	1704.
THOUS CU M		1564.	2016.	2102.	2102.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	829.	256.	82.	43.	12369.
CMS	23.	7.	2.	1.	350.
INCHES		2.64	3.41	3.55	3.55
MM		67.11	86.54	90.20	90.20
AC-FT		127.	163.	170.	170.
THOUS CU M		156.	202.	210.	210.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4143.	1278.	412.	215.	61845.
CMS	117.	36.	12.	6.	1751.
INCHES		13.21	17.03	17.76	17.76
MM		335.57	432.68	451.01	451.01
AC-FT		634.	817.	852.	852.
THOUS CU M		782.	1008.	1051.	1051.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8286.	2556.	824.	429.	123690.
CMS	235.	72.	23.	12.	3503.
INCHES		26.42	34.07	35.51	35.51
MM		671.14	865.35	902.02	902.02
AC-FT		1268.	1634.	1704.	1704.
THOUS CU M		1564.	2016.	2102.	2102.

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HYDROGRAPH ROUTING

ROUTE THRU LAMOTTE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-881.	-1

STAGE	881.00	882.00	883.00	884.00	885.00	886.00	888.00	890.00	895.00
FLOW	0.00	40.00	140.00	300.00	510.00	800.00	1610.00	2760.00	7340.00
SURFACE AREA=	0.	18.	30.	41.	50.	60.	73.		
CAPACITY=	0.	72.	191.	332.	468.	633.	899.		
ELEVATION=	869.	881.	886.	890.	893.	896.	900.		

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
881.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
883.9	2.9	1.5	750.

CREST LENGTH AT OR BELOW ELEVATION	70.	300.	635.	790.	890.	995.	1100.
	883.9	884.0	884.4	885.0	890.0	895.0	900.0

STATION 2. PLAN 1. RATIO 1

PEAK OUTFLOW IS 383. AT TIME 40.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	383.	210.	74.	38.	11035.
CMS	11.	6.	2.	1.	312.
INCHES		2.17	3.06	3.17	3.17
MM		55.05	77.78	80.47	80.47
AC-FT		104.	147.	152.	152.
THOUS CU M		128.	181.	187.	187.

STATION 2. PLAN 1. RATIO 2

PEAK OUTFLOW IS 3988. AT TIME 40.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3988.	1254.	401.	207.	59518.
CMS	113.	36.	11.	6.	1685.
INCHES		12.96	16.56	17.09	17.09
MM		329.29	420.67	434.04	434.04
AC-FT		622.	795.	820.	820.
THOUS CU M		767.	980.	1011.	1011.

STATION 2. PLAN 1. RATIO 3

PEAK OUTFLOW IS 8062. AT TIME 40.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8062.	2548.	809.	418.	120456.
CMS	228.	72.	23.	12.	3411.
INCHES		26.33	33.44	34.58	34.58
MM		668.87	849.39	878.43	878.43
AC-FT		1263.	1604.	1659.	1659.
THOUS CU M		1558.	1979.	2047.	2047.

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HYDROGRAPH ROUTING

REACH 2-3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	798.0	840.0	4000.	.02000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 840.00 200.00 820.00 550.00 800.00 570.00 798.00 580.00 798.00
600.00 800.00 700.00 820.00 1200.00 0.00

STORAGE	0.00	17933.49	18048.83	18174.54	18310.62	18457.06	18613.88	18781.07	18958.63
	19344.84	19550.29	19760.22	19974.63	20193.54	20416.93	20644.81	20877.19	21114.03
OUTFLOW	0.00	24074105.28	24064732.24	24064581.69	24073773.58	24092420.57	24120629.42	24158503.00	24206141.79 24
	24341228.83	24628254.74	24919742.79	25215738.52	25516297.55	25821482.31	26131359.87	26446000.56	26765476.91 27
STAGE	798.00	800.21	802.42	804.63	806.84	809.05	811.26	813.47	815.68
	820.11	822.32	824.53	826.74	828.95	831.16	833.37	835.58	837.79
FLOW	0.00	24074105.28	24064732.24	24064581.69	24073773.58	24092420.57	24120629.42	24158503.00	24206141.79 24
	24341228.83	24628254.74	24919742.79	25215738.52	25516297.55	25821482.31	26131359.87	26446000.56	26765476.91 27

STATION 3, PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	382.	210.	74.	38.	11033.
CMS	11.	6.	2.	1.	312.
INCHES		2.17	3.06	3.17	3.17
MM		55.05	77.76	80.46	80.46
AC-FT		104.	147.	152.	152.
THOUS CU M		128.	181.	187.	187.

MAXIMUM STORAGE = 0.

MAXIMUM STAGE IS 798.0

STATION 3, PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4000.	1254.	401.	207.	59512.
CMS	113.	36.	11.	6.	1685.
INCHES		12.97	16.56	17.09	17.09
MM		329.32	420.64	434.00	434.00
AC-FT		622.	795.	820.	820.
THOUS CU M		767.	980.	1011.	1011.

MAXIMUM STORAGE = 3.

MAXIMUM STAGE IS 798.0

STATION 3, PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	8102.	2548.	809.	418.	120447.
CMS	229.	72.	23.	12.	3411.
INCHES		26.33	33.44	34.58	34.58
MM		668.84	849.34	878.37	878.37
AC-FT		1263.	1604.	1659.	1659.
THOUS CU M		1558.	1979.	2046.	2046.

MAXIMUM STORAGE = 6.

MAXIMUM STAGE IS 798.0

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HYDROGRAPH ROUTING

REACH 3-4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	776.0	800.0	4000.	.00550

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

	0.00	800.00	375.00	780.00	600.00	778.00	658.00	776.00	668.00	776.00
	725.00	778.00	800.00	780.00	900.00	800.00				
STORAGE	0.00	5.37	20.35	54.99	105.19	159.13	216.54	277.44	341.82
	481.01	555.82	634.12	715.89	801.15	889.88	982.09	1077.79	1176.96
OUTFLOW	0.00	102.67	624.12	2010.78	4737.15	8619.54	13540.28	19465.97	26385.25
	43212.84	53140.09	64094.81	76093.60	89154.47	103296.44	118539.21	134903.02	152408.46
STAGE	776.00	777.26	778.53	779.79	781.05	782.32	783.58	784.84	786.11
	788.63	789.89	791.16	792.42	793.68	794.95	796.21	797.47	798.74
FLOW	0.00	102.67	624.12	2010.78	4737.15	8619.54	13540.28	19465.97	26385.25
	43212.84	53140.09	64094.81	76093.60	89154.47	103296.44	118539.21	134903.02	152408.46

STATION 4, PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	335.	204.	73.	38.	10863.
CMS	9.	6.	2.	1.	308.
INCHES		2.15	3.02	3.12	3.12
MM		54.62	76.65	79.22	79.22
AC-FT		103.	145.	150.	150.
THOUS CU M		127.	179.	185.	185.

MAXIMUM STORAGE = 12.

MAXIMUM STAGE IS 777.8

STATION 4, PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3295.	1245.	398.	205.	59117.
CMS	93.	35.	11.	6.	1674.
INCHES		12.87	16.47	16.97	16.97
MM		326.78	418.37	431.11	431.11
AC-FT		617.	790.	814.	814.
THOUS CU M		761.	975.	1004.	1004.

MAXIMUM STORAGE = 79.

MAXIMUM STAGE IS 780.4

STATION 4, PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7000.	2526.	806.	416.	119913.
CMS	198.	72.	23.	12.	3396.
INCHES		26.11	33.32	34.43	34.43
MM		663.11	846.37	874.47	874.47
AC-FT		1292.	1599.	1652.	1652.
THOUS CU M		1545.	1972.	2037.	2037.

MAXIMUM STORAGE = 137.

MAXIMUM STAGE IS 781.8

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SUB-AREA RUNOFF COMPUTATION

INFLOW SUB-AREA(B)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	3.40	0.00	4.30	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.50	102.00	120.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-87.00	0.00	0.00

CURVE NO = -87.00 WETNESS = -1.00 EFFECT CN = 87.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .50

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.50

UNIT HYDROGRAPH 17 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .50 VOL= 1.00

499. 1706. 2716. 2716. 2116. 1267. 789. 511. 317. 199.
125. 78. 49. 31. 21. 12. 4.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

1.01	.10	1	.00	0.00	.00	5.	1.02	.10	145	.03	.03	.00	49.
1.01	.20	2	.00	0.00	.00	4.	1.02	.20	146	.03	.03	.00	87.
1.01	.30	3	.00	0.00	.00	4.	1.02	.30	147	.03	.03	.00	147.
1.01	.40	4	.00	0.00	.00	4.	1.02	.40	148	.03	.03	.00	208.
1.01	.50	5	.00	0.00	.00	3.	1.02	.50	149	.03	.03	.00	255.
1.01	1.00	6	.00	0.00	.00	3.	1.02	1.00	150	.03	.03	.00	284.
1.01	1.10	7	.00	0.00	.00	3.	1.02	1.10	151	.03	.03	.00	302.
1.01	1.20	8	.00	0.00	.00	2.	1.02	1.20	152	.03	.03	.00	314.
1.01	1.30	9	.00	0.00	.00	2.	1.02	1.30	153	.03	.03	.00	322.
1.01	1.40	10	.00	0.00	.00	2.	1.02	1.40	154	.03	.03	.00	327.
1.01	1.50	11	.00	0.00	.00	2.	1.02	1.50	155	.03	.03	.00	330.
1.01	2.00	12	.00	0.00	.00	2.	1.02	2.00	156	.03	.03	.00	333.
1.01	2.10	13	.00	0.00	.00	2.	1.02	2.10	157	.03	.03	.00	335.
1.01	2.20	14	.00	0.00	.00	1.	1.02	2.20	158	.03	.03	.00	336.
1.01	2.30	15	.00	0.00	.00	1.	1.02	2.30	159	.03	.03	.00	337.
1.01	2.40	16	.00	0.00	.00	1.	1.02	2.40	160	.03	.03	.00	338.
1.01	2.50	17	.00	0.00	.00	1.	1.02	2.50	161	.03	.03	.00	339.
1.01	3.00	18	.00	0.00	.00	1.	1.02	3.00	162	.03	.03	.00	340.
1.01	3.10	19	.00	0.00	.00	1.	1.02	3.10	163	.03	.03	.00	340.
1.01	3.20	20	.00	0.00	.00	1.	1.02	3.20	164	.03	.03	.00	341.
1.01	3.30	21	.00	0.00	.00	1.	1.02	3.30	165	.03	.03	.00	342.
1.01	3.40	22	.00	0.00	.00	1.	1.02	3.40	166	.03	.03	.00	342.
1.01	3.50	23	.00	0.00	.00	1.	1.02	3.50	167	.03	.03	.00	343.
1.01	4.00	24	.00	0.00	.00	1.	1.02	4.00	168	.03	.03	.00	343.
1.01	4.10	25	.00	0.00	.00	1.	1.02	4.10	169	.03	.03	.00	344.
1.01	4.20	26	.00	0.00	.00	0.	1.02	4.20	170	.03	.03	.00	345.
1.01	4.30	27	.00	0.00	.00	0.	1.02	4.30	171	.03	.03	.00	345.
1.01	4.40	28	.00	0.00	.00	0.	1.02	4.40	172	.03	.03	.00	346.
1.01	4.50	29	.00	0.00	.00	0.	1.02	4.50	173	.03	.03	.00	346.
1.01	5.00	30	.00	0.00	.00	0.	1.02	5.00	174	.03	.03	.00	347.
1.01	5.10	31	.00	0.00	.00	0.	1.02	5.10	175	.03	.03	.00	347.
1.01	5.20	32	.00	0.00	.00	0.	1.02	5.20	176	.03	.03	.00	348.
1.01	5.30	33	.00	0.00	.00	0.	1.02	5.30	177	.03	.03	.00	348.
1.01	5.40	34	.00	0.00	.00	0.	1.02	5.40	178	.03	.03	.00	349.
1.01	5.50	35	.00	0.00	.00	0.	1.02	5.50	179	.03	.03	.00	349.
1.01	6.00	36	.00	0.00	.00	0.	1.02	6.00	180	.03	.03	.00	350.
1.01	6.10	37	.01	0.00	.01	0.	1.02	6.10	181	.13	.12	.01	397.
1.01	6.20	38	.01	0.00	.01	0.	1.02	6.20	182	.13	.12	.01	558.
1.01	6.30	39	.01	0.00	.01	0.	1.02	6.30	183	.13	.12	.01	814.
1.01	6.40	40	.01	0.00	.01	0.	1.02	6.40	184	.13	.12	.01	1072.
1.01	6.50	41	.01	0.00	.01	0.	1.02	6.50	185	.13	.12	.01	1275.
1.01	7.00	42	.01	0.00	.01	0.	1.02	7.00	186	.13	.12	.01	1399.
1.01	7.10	43	.01	0.00	.01	0.	1.02	7.10	187	.13	.12	.01	1479.
1.01	7.20	44	.01	0.00	.01	0.	1.02	7.20	188	.13	.12	.01	1533.
1.01	7.30	45	.01	0.00	.01	0.	1.02	7.30	189	.13	.12	.01	1569.
1.01	7.40	46	.01	0.00	.01	0.	1.02	7.40	190	.13	.12	.01	1593.
1.01	7.50	47	.01	0.00	.01	0.	1.02	7.50	191	.13	.13	.01	1610.
1.01	8.00	48	.01	0.00	.01	0.	1.02	8.00	192	.13	.13	.01	1622.
1.01	8.10	49	.01	0.00	.01	0.	1.02	8.10	193	.13	.13	.01	1631.
1.01	8.20	50	.01	0.00	.01	0.	1.02	8.20	194	.13	.13	.01	1639.
1.01	8.30	51	.01	0.00	.01	0.	1.02	8.30	195	.13	.13	.01	1645.
1.01	8.40	52	.01	0.00	.01	0.	1.02	8.40	196	.13	.13	.01	1650.
1.01	8.50	53	.01	0.00	.01	0.	1.02	8.50	197	.13	.13	.01	1654.
1.01	9.00	54	.01	0.00	.01	0.	1.02	9.00	198	.13	.13	.01	1658.
1.01	9.10	55	.01	0.00	.01	0.	1.02	9.10	199	.13	.13	.01	1661.
1.01	9.20	56	.01	0.00	.01	0.	1.02	9.20	200	.13	.13	.01	1664.
1.01	9.30	57	.01	0.00	.01	0.	1.02	9.30	201	.13	.13	.01	1667.
1.01	9.40	58	.01	.00	.01	0.	1.02	9.40	202	.13	.13	.00	1670.
1.01	9.50	59	.01	.00	.01	0.	1.02	9.50	203	.13	.13	.00	1672.

1.01	10.00	60	.01	.00	.01	1.	1.02	10.00	204	.13	.13	.00	1675.
1.01	10.10	61	.01	.00	.01	1.	1.02	10.10	205	.13	.13	.00	1677.
1.01	10.20	62	.01	.00	.01	2.	1.02	10.20	206	.13	.13	.00	1679.
1.01	10.30	63	.01	.00	.01	4.	1.02	10.30	207	.13	.13	.00	1682.
1.01	10.40	64	.01	.00	.01	5.	1.02	10.40	208	.13	.13	.00	1684.
1.01	10.50	65	.01	.00	.01	7.	1.02	10.50	209	.13	.13	.00	1685.
1.01	11.00	66	.01	.00	.01	8.	1.02	11.00	210	.13	.13	.00	1687.
1.01	11.10	67	.01	.00	.01	10.	1.02	11.10	211	.13	.13	.00	1689.
1.01	11.20	68	.01	.00	.01	11.	1.02	11.20	212	.13	.13	.00	1691.
1.01	11.30	69	.01	.00	.01	13.	1.02	11.30	213	.13	.13	.00	1692.
1.01	11.40	70	.01	.00	.01	14.	1.02	11.40	214	.13	.13	.00	1694.
1.01	11.50	71	.01	.00	.01	16.	1.02	11.50	215	.13	.13	.00	1695.
1.01	12.00	72	.01	.00	.01	17.	1.02	12.00	216	.13	.13	.00	1697.
1.01	12.10	73	.03	.01	.03	21.	1.02	12.10	217	.45	.44	.01	1853.
1.01	12.20	74	.03	.01	.03	31.	1.02	12.20	218	.45	.44	.01	2385.
1.01	12.30	75	.03	.01	.03	48.	1.02	12.30	219	.45	.44	.01	3232.
1.01	12.40	76	.03	.01	.02	67.	1.02	12.40	220	.45	.44	.01	4081.
1.01	12.50	77	.03	.01	.02	86.	1.02	12.50	221	.45	.44	.01	4746.
1.01	13.00	78	.03	.01	.02	103.	1.02	13.00	222	.45	.44	.01	5147.
1.01	13.10	79	.04	.02	.03	119.	1.02	13.10	223	.54	.53	.01	5444.
1.01	13.20	80	.04	.02	.03	138.	1.02	13.20	224	.54	.53	.01	5762.
1.01	13.30	81	.04	.02	.02	158.	1.02	13.30	225	.54	.53	.01	6109.
1.01	13.40	82	.04	.02	.02	179.	1.02	13.40	226	.54	.53	.01	6420.
1.01	13.50	83	.04	.02	.02	198.	1.02	13.50	227	.54	.54	.01	6654.
1.01	14.00	84	.04	.02	.02	214.	1.02	14.00	228	.54	.54	.01	6798.
1.01	14.10	85	.05	.03	.03	232.	1.02	14.10	229	.68	.67	.01	6956.
1.01	14.20	86	.05	.03	.02	255.	1.02	14.20	230	.68	.67	.01	7246.
1.01	14.30	87	.05	.03	.02	283.	1.02	14.30	231	.68	.67	.01	7650.
1.01	14.40	88	.05	.03	.02	312.	1.02	14.40	232	.68	.67	.00	8041.
1.01	14.50	89	.05	.03	.02	337.	1.02	14.50	233	.68	.67	.00	8343.
1.01	15.00	90	.05	.03	.02	358.	1.02	15.00	234	.68	.67	.00	8525.
1.01	15.10	91	.05	.03	.02	374.	1.02	15.10	235	.62	.61	.00	8610.
1.01	15.20	92	.08	.05	.03	395.	1.02	15.20	236	1.03	1.02	.01	8789.
1.01	15.30	93	.14	.10	.05	458.	1.02	15.30	237	1.85	1.84	.01	9783.
1.01	15.40	94	.36	.26	.10	674.	1.02	15.40	238	4.62	4.61	.02	13540.
1.01	15.50	95	.10	.08	.02	1041.	1.02	15.50	239	1.34	1.33	.00	19852.
1.01	16.00	96	.06	.05	.01	1328.	1.02	16.00	240	.82	.82	.00	24548.
1.01	16.10	97	.05	.04	.01	1348.	1.02	16.10	241	.63	.63	.00	24409.
1.01	16.20	98	.05	.04	.01	1179.	1.02	16.20	242	.63	.63	.00	20988.
1.01	16.30	99	.05	.04	.01	942.	1.02	16.30	243	.63	.63	.00	16494.
1.01	16.40	100	.05	.04	.01	781.	1.02	16.40	244	.63	.63	.00	13462.
1.01	16.50	101	.05	.04	.01	683.	1.02	16.50	245	.63	.63	.00	11574.
1.01	17.00	102	.05	.04	.01	620.	1.02	17.00	246	.63	.63	.00	10345.
1.01	17.10	103	.04	.03	.01	577.	1.02	17.10	247	.50	.49	.00	9510.
1.01	17.20	104	.04	.03	.01	540.	1.02	17.20	248	.50	.49	.00	8796.
1.01	17.30	105	.04	.03	.01	503.	1.02	17.30	249	.50	.49	.00	8128.
1.01	17.40	106	.04	.03	.01	473.	1.02	17.40	250	.50	.49	.00	7574.
1.01	17.50	107	.04	.03	.01	451.	1.02	17.50	251	.50	.49	.00	7170.
1.01	18.00	108	.04	.03	.01	439.	1.02	18.00	252	.50	.49	.00	6929.
1.01	18.10	109	.00	.00	.00	416.	1.02	18.10	253	.04	.04	.00	6539.
1.01	18.20	110	.00	.00	.00	361.	1.02	18.20	254	.04	.04	.00	5657.
1.01	18.30	111	.00	.00	.00	280.	1.02	18.30	255	.04	.04	.00	4367.
1.01	18.40	112	.00	.00	.00	199.	1.02	18.40	256	.04	.04	.00	3112.
1.01	18.50	113	.00	.00	.00	137.	1.02	18.50	257	.04	.04	.00	2141.
1.01	19.00	114	.00	.00	.00	100.	1.02	19.00	258	.04	.04	.00	1559.
1.01	19.10	115	.00	.00	.00	77.	1.02	19.10	259	.04	.04	.00	1218.
1.01	19.20	116	.00	.00	.00	65.	1.02	19.20	260	.04	.04	.00	1112.
1.01	19.30	117	.00	.00	.00	60.	1.02	19.30	261	.04	.04	.00	1014.
1.01	19.40	118	.00	.00	.00	54.	1.02	19.40	262	.04	.04	.00	926.
1.01	19.50	119	.00	.00	.00	50.	1.02	19.50	263	.04	.04	.00	844.

1.01	20.00	120	.00	.00	.00	45.	1.02	20.00	264	.04	.04	.00	771.
1.01	20.10	121	.00	.00	.00	41.	1.02	20.10	265	.04	.04	.00	709.
1.01	20.20	122	.00	.00	.00	39.	1.02	20.20	266	.04	.04	.00	642.
1.01	20.30	123	.00	.00	.00	38.	1.02	20.30	267	.04	.04	.00	587.
1.01	20.40	124	.00	.00	.00	38.	1.02	20.40	268	.04	.04	.00	582.
1.01	20.50	125	.00	.00	.00	38.	1.02	20.50	269	.04	.04	.00	580.
1.01	21.00	126	.00	.00	.00	38.	1.02	21.00	270	.04	.04	.00	580.
1.01	21.10	127	.00	.00	.00	38.	1.02	21.10	271	.04	.04	.00	580.
1.01	21.20	128	.00	.00	.00	38.	1.02	21.20	272	.04	.04	.00	580.
1.01	21.30	129	.00	.00	.00	38.	1.02	21.30	273	.04	.04	.00	580.
1.01	21.40	130	.00	.00	.00	38.	1.02	21.40	274	.04	.04	.00	580.
1.01	21.50	131	.00	.00	.00	38.	1.02	21.50	275	.04	.04	.00	580.
1.01	22.00	132	.00	.00	.00	38.	1.02	22.00	276	.04	.04	.00	580.
1.01	22.10	133	.00	.00	.00	38.	1.02	22.10	277	.04	.04	.00	580.
1.01	22.20	134	.00	.00	.00	38.	1.02	22.20	278	.04	.04	.00	580.
1.01	22.30	135	.00	.00	.00	38.	1.02	22.30	279	.04	.04	.00	580.
1.01	22.40	136	.00	.00	.00	38.	1.02	22.40	280	.04	.04	.00	580.
1.01	22.50	137	.00	.00	.00	38.	1.02	22.50	281	.04	.04	.00	580.
1.01	23.00	138	.00	.00	.00	38.	1.02	23.00	282	.04	.04	.00	580.
1.01	23.10	139	.00	.00	.00	38.	1.02	23.10	283	.04	.04	.00	580.
1.01	23.20	140	.00	.00	.00	38.	1.02	23.20	284	.04	.04	.00	580.
1.01	23.30	141	.00	.00	.00	38.	1.02	23.30	285	.04	.04	.00	580.
1.01	23.40	142	.00	.00	.00	38.	1.02	23.40	286	.04	.04	.00	580.
1.01	23.50	143	.00	.00	.00	38.	1.02	23.50	287	.04	.04	.00	580.
1.02	0.00	144	.00	.00	.00	38.	1.03	0.00	288	.04	.04	.00	580.
									SUM	37.10	35.37	1.73	464388.
										(942.)(	898.)(	44.)(13150.00)	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	24548.	9569.	3097.	1611.	464098.
CMS	695.	271.	88.	46.	13142.
INCHES		20.18	33.84	35.27	35.27
MM		665.02	859.51	895.89	895.89
AC-FT		4745.	6133.	6393.	6393.
THOUS CU M		5853.	7565.	7885.	7885.

HYDROGRAPH AT STA 5 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2455.	927.	309.	161.	46410.
CMS	70.	27.	9.	5.	1314.
INCHES		2.62	3.38	3.53	3.53
MM		66.50	85.99	89.59	89.59
AC-FT		475.	613.	639.	639.
THOUS CU M		585.	756.	789.	789.

HYDROGRAPH AT STA 5 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12274.	4785.	1546.	806.	232049.
CMS	348.	135.	44.	23.	6571.
INCHES		13.09	16.92	17.64	17.64
MM		332.51	429.76	447.94	447.94
AC-FT		2373.	3066.	3196.	3196.
THOUS CU M		2927.	3782.	3943.	3943.

HYDROGRAPH AT STA 5 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	24548.	9569.	3092.	1611.	464098.
CMS	695.	271.	88.	46.	13142.
INCHES		26.18	33.84	35.27	35.27
MM		665.02	859.51	895.89	895.89
AC-FT		4745.	6133.	6393.	6393.
THOUS CU M		5853.	7565.	7885.	7885.

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COMBINE HYDROGRAPHS

COMBINE

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	2	0	0	0	0	1	0	0

SUM OF 2 HYDROGRAPHS AT 6 PLAN 1 RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	1.	1.	1.	1.	1.	1.
2.	2.	2.	3.	5.	7.	9.	10.	12.	14.
16.	18.	20.	22.	24.	27.	29.	32.	35.	37.
39.	42.	48.	70.	107.	136.	139.	123.	100.	84.
75.	69.	65.	62.	58.	55.	53.	52.	50.	65.
37.	29.	23.	19.	16.	15.	14.	14.	13.	12.
12.	11.	11.	11.	11.	11.	10.	10.	10.	10.
10.	10.	10.	9.	9.	9.	9.	9.	9.	9.
9.	8.	8.	8.	9.	13.	19.	25.	30.	33.
34.	36.	37.	37.	38.	38.	38.	38.	39.	39.
39.	39.	39.	40.	40.	40.	40.	40.	40.	41.
41.	41.	41.	41.	41.	41.	41.	42.	42.	42.
47.	63.	89.	115.	135.	148.	157.	163.	167.	171.
173.	175.	177.	178.	180.	181.	182.	183.	184.	185.
186.	187.	188.	189.	190.	191.	192.	192.	193.	194.
195.	195.	196.	197.	197.	198.	214.	268.	353.	439.
507.	550.	583.	619.	658.	695.	729.	744.	764.	801.
848.	893.	930.	955.	974.	1001.	1110.	1499.	2151.	2653.
2680.	2384.	1970.	1681.	1490.	1357.	1263.	1181.	1109.	1041.
992.	960.	913.	817.	678.	542.	432.	360.	312.	289.
266.	246.	229.	213.	199.	186.	174.	167.	161.	158.
154.	150.	147.	143.	139.	135.	132.	128.	125.	122.
119.	116.	113.	111.	108.	106.	104.	103.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2680.	1130.	382.	199.	57273.
CMS	76.	32.	11.	6.	1622.
INCHES		2.44	3.31	3.44	3.44
MM		62.08	84.01	87.42	87.42
AC-FT		560.	758.	789.	789.
THOUS CU M		691.	935.	973.	973.

SUM OF 2 HYDROGRAPHS AT 6 PLAN 1 RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	15499.	6015.	1944.	1011.	291166.
CMS	439.	170.	55.	29.	8245.
INCHES		13.01	16.83	17.50	17.50
MM		330.54	427.37	444.42	444.42
AC-FT		2983.	3857.	4011.	4011.
THOUS CU M		3679.	4757.	4947.	4947.

SUM OF 2 HYDROGRAPHS AT 6 PLAN 1 RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	31409.	12091.	3898.	2028.	584011.
CMS	889.	342.	110.	57.	16537.
INCHES		26.16	33.73	35.09	35.09
MM		664.37	856.76	891.41	891.41
AC-FT		5995.	7732.	8044.	8044.
THOUS CU M		7395.	9537.	9922.	9922.

HYDROGRAPH ROUTING

ROUTE THRU LAKE HARMONY

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-778.	-1

STAGE	778.00	779.00	780.00	781.00	782.00	783.00	784.00	785.00	790.00
FLOW	0.00	170.00	500.00	940.00	1480.00	2120.00	2860.00	3680.00	9240.00
SURFACE AREA=	0.	37.	60.	80.	90.	100.	120.	135.	
CAPACITY=	0.	185.	281.	560.	730.	1015.	1674.	2311.	
ELEVATION=	763.	778.	780.	784.	786.	789.	795.	800.	

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
778.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
781.0	2.9	1.5	524.

CREST LENGTH AT OR BELOW ELEVATION	5. 781.0	127. 782.0	750. 783.0	835. 785.0	920. 787.0	1015. 789.0	1100. 791.0	1200. 793.0	1290. 795.0	1500. 800.0

STATION 6, PLAN 1, RATIO 1

PEAK OUTFLOW IS 1557. AT TIME 40.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1557.	1003.	361.	188.	54001.
CMS	44.	28.	10.	5.	1529.
INCHES		2.17	3.13	3.25	3.25
MM		55.11	79.41	82.43	82.43
AC-FT		497.	717.	744.	744.
THOUS CU M		613.	884.	917.	917.

STATION 6. PLAN 1. RATIO 2

PEAK OUTFLOW IS 14466. AT TIME 40.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14466.	5697.	1906.	987.	284236.
CMS	410.	167.	54.	28.	8049.
INCHES		12.76	16.49	17.08	17.08
MM		324.06	418.87	433.84	433.84
AC-FT		2924.	3780.	3915.	3915.
THOUS CU M		3607.	4663.	4829.	4829.

STATION 6. PLAN 1. RATIO 3

PEAK OUTFLOW IS 30185. AT TIME 40.17 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	30185.	12029.	3842.	1992.	573612.
CMS	855.	341.	109.	56.	16243.
INCHES		26.02	33.25	34.47	34.47
MM		660.98	844.45	875.53	875.53
AC-FT		5965.	7620.	7901.	7901.
THOUS CU M		7358.	9400.	9746.	9746.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .50	RATIO 3 1.00
HYDROGRAPH AT	1	.90 (2.33)	1	829. (23.46)	4143. (117.32)	8286. (234.64)
ROUTED TO	2	.90 (2.33)	1	383. (10.84)	3988. (112.94)	8062. (228.29)
ROUTED TO	3	.90 (2.33)	1	382. (10.82)	4000. (113.27)	8102. (229.44)
ROUTED TO	4	.90 (2.33)	1	335. (9.48)	3295. (93.29)	7000. (198.21)
HYDROGRAPH AT	5	3.40 (8.81)	1	2455. (69.51)	12274. (347.56)	24548. (695.11)
2 COMBINED	6	4.30 (11.14)	1	2680. (75.89)	15499. (438.88)	31409. (889.39)
ROUTED TO	6	4.30 (11.14)	1	1557. (44.09)	14466. (409.64)	30185. (854.76)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE | SPILLWAY CREST | TOP OF DAM

ELEVATION	881.00	881.00	883.90
STORAGE	72.	72.	134.
OUTFLOW	0.	0.	284.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	884.10	.20	138.	383.	1.17	40.33	0.00
.50	885.42	1.52	174.	3288.	6.50	40.00	0.00
1.00	886.23	2.33	198.	8062.	11.83	40.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	382.	798.0	40.33
.50	4000.	798.0	40.00
1.00	8102.	798.0	40.00

PLAN 1 STATION 4

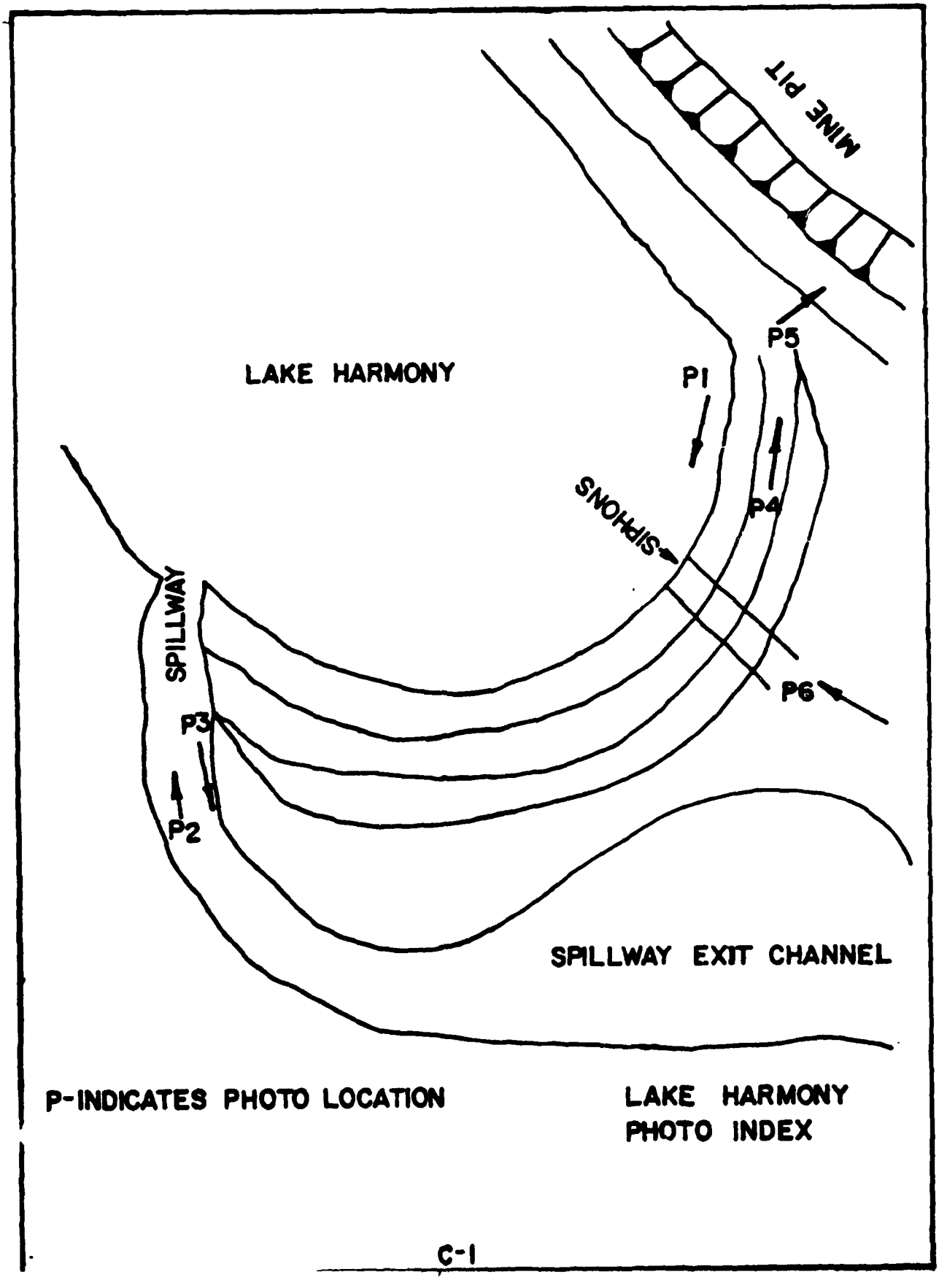
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	335.	777.8	40.67
.50	3295.	780.4	40.17
1.00	7000.	781.8	40.17

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	778.00	778.00	781.00
	STORAGE	185.	185.	343.
	OUTFLOW	0.	0.	940.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	781.91	.91	404.	1557.	3.00	40.83	0.00
.50	785.04	4.04	646.	14466.	9.33	40.33	0.00
1.00	786.91	5.91	814.	30185.	14.83	40.17	0.00

PHOTOGRAPHS



P-INDICATES PHOTO LOCATION

LAKE HARMONY
PHOTO INDEX

Photograph No. 2

Spillway control section.

Photograph No. 3

Spillway exit channel.

Photograph No. 4

Low point on top of dam adjacent to road.

Photograph No. 5

Mine pit adjacent to road.

Photograph No. 6

Downstream slope of dam and siphons.


ATE
LME